

98/03878 BioStirling: a small biomass power conversion system using an advanced Stirling engine

Johansson, L. *et al.* *Bioenergy '96, Proc. Natl. Bioenergy Conf., 7th*, 1996, 1, 312-316.

The last ten years has seen a dramatic increase in the need for small power conversion systems to serve rural and/or remote needs. The requirements for systems <100 kW are very similar, whether the need is defined as 'rural electrification' in developed countries, or as 'village power' in developing countries. There is no doubt concerning the availability of biomass fuel resources to serve such systems, be they agricultural, forestry, animal or urban wastes. The absence of a biomass power conversion system characterized by reliability, cost effectiveness, low pollution, and ease of maintenance, has been the main inhibiting factor. Stirling Thermal Motors of Ann Arbor, Michigan, is recognized as the world-wide leader in the development and application of Stirling engine technology. It is currently demonstrating a 'BioStirling' power conversion system which combines its unique STM4-120 engine rated at 25 kW with a proven commercial gasifier. The BioStirling proof-of-concept demonstration is funded by DOE's National Renewable Energy Laboratory and was due for completion in late 1996, with field demonstrations in 1997 and commercial availability in 1998.

98/03879 Canadian research and development activities on the production of fuel ethanol from lignocellulosic feed-stocks

Cruickshank, W. H. and Barraud, C. *Braz. Symp. Chem. Lignins Other Wood Compon., Proc., 5th*, 1997, 6, 397-403.

An abundant supply of lignocellulosic residues is generated in Canada's forest and agriculture sectors. Based on its role in supporting sustainable development, Natural Resources Canada maintains an active research and development program to develop technology for the production of fuel ethanol from those potentially low cost materials. This work is carried out under the biochemical conversion component of Natural Resources Canada Bioenergy Development Program. The strategy is to support research that will reduce the cost of conversion of biomass to fuel ethanol in order to make it price competitive with gasoline by the turn of the century. With an annual budget of approximately US\$600,000, this work focuses its support on research to improve the following individual process steps within the overall conversion of biomass to ethanol: softwood pre-treatment, improved hydrolysis of feedstocks, efficient processes for fermentation of xylose and other five-carbon sugars and improved methods for ethanol recovery. Several technologies developed with the support of the programme are now nearing commercial implementation.

98/03880 Carbon cycle for rapeseed oil biodiesel fuels

Peterson, C. L. and Hustrulid, T. *Biomass and Bioenergy*, 1998, 14, (2), 91-101.

Carbon dioxide, which makes up half of the gas accumulation problem which causes the greenhouse effect, is produced during respiration and combustion processes. An outline of the carbon cycle for rapeseed oil-derived fuels is presented here, examining plant processes, fuel chemistry and combustion with respect to carbon. A comparison of carbon dioxide emissions from the combustion of rapeseed oil biodiesel and petroleum diesel is made. The carbon dioxide released by petroleum diesel was fixed from the atmosphere during the formative years of the earth. Carbon dioxide released by biodiesel, however, is fixed by the plant in a recent year and is recycled. It is widely believed that global warming is occurring because of the rapid release of CO₂ in processes such as petroleum diesel combustion. Biodiesel could therefore reduce the accumulation of CO₂ in the atmosphere.

98/03881 Chicken-bio nuggets gasification process

Sheth, A. C. *Bioenergy '96, Proc. Natl. Bioenergy Conf., 7th*, 1996, 2, 866-873.

An innovative idea involving the gasification of waste products from the poultry industry and industrial wood/biomass-based residues in 'as-is' or aggregate form, known as the chicken-bio nuggets gasification process, is under evaluation at the University of Tennessee Space Institute (UTSI). The potassium salts present in the poultry waste and biomass can act as a catalyst in reducing the severity of the thermal gasification. The mixture of these waste products can thus be gasified at a much lower temperature—1300–1400°F as opposed to 1800–2000°F for conventional thermal gasification. These potassium salts also catalyse the reaction by accelerating gasification and enhancing methanation. The product gas from this UTSI concept can therefore be richer in methane and can probably be used as a source of fuel or chemical feedstock. Exxon Research and Engineering Company has tested a similar catalytic gasification concept in a fluid-bed gasifier using coal in a one ton/day pilot plant in Baytown, Texas. If this technology meets technical and economic demands, it could be extended to include other kinds of waste products such as cow manure and swine wastes.

98/03882 Cogasifying biomass with other domestic fuels

Green, A. *et al.* *Bioenergy '96, Proc. Natl. Bioenergy Conf., 7th*, 1996, 1, 325-332.

In the US, virtually all new electricity generation technology makes use of efficient gas turbines (GT) in natural gas combined cycle systems. It is conjectured that this trend will accelerate in the face of utility deregulation and environmental regulations. If a low cost co-gasifier fed by low cost feedstocks can be coupled with a GT system, solid fuel may provide viable competition. In addition, it would be helpful if valuable by-products or

additional community purposes are served. On-site co-gasification of biomass with other domestic fuels in an indirectly heated gasifier is studied here as a cost reduction strategy for solid fuel based GT systems. Advantageous feedstocks or feedstock blends are investigated using molecular modelling to extract information from gaseous yield data. Co-gasification of carbonaceous fuels such as coals, coke and chars with oxygenated fuels such as biomass, MSW, RDF and dried sewage sludge appears to have technological, economic and environmental advantages, potentially leading to simpler and lower capital and operating cost solid fuel gasifier systems.

98/03883 Combustion characteristics of leached biomass

Jenkins, B. M. *et al.* *Dev. Thermochem. Biomass Convers.*, 1997, 2, 1316-1330. Edited by Bridgwater, A. V. and Boocock, D. G. B., Blackie, London, UK.

Substantial improvements in the combustion behaviour of straw, grass and other types of biomass results from their simple leaching with water. Although the economic feasibility of leaching is case specific, leaching does extract large amounts of alkali metals and chlorine which improve the fouling, slagging, and burning characteristics of biomass fuels, especially grasses and straws. Increases in the fusion temperature of ash arise from extraction of alkali elements by leaching, and decreases are, in general, observed in the amount of volatile ash. Pilot combustion tests decreases are, in general, observed in the amount of volatile ash. Pilot combustion tests showed lower rates of fouling when burning leached rice straw compared to unleached fresh material. Pyrolysis rates obtained via dynamic thermogravimetric analysis are slower for leached materials, probably as a result of a reduction in catalytic effects due to alkali metal salts, although volatile matter emission is observed to terminate earlier under isothermal heating for leached compared to unleached fuel. For the highly refractory fuel—rice straw—improvements in the ignition and burning characteristics of single straws have been observed to accompany leaching, possibly as a result of lower chlorine activity in terminating free radical chain reactions.

98/03884 Commercial steam reforming catalysts to improve biomass gasification with steam-oxygen mixtures 1. Hot gas upgrading by the catalytic reactor

Caballero, M. A. *et al.* *Ind. Eng. Chem. Res.*, 1997, 36, (12), 5227-5239.

Commercial catalysts for steam reforming (nickel-based) are used for hot gas cleaning and upgrading in biomass gasification with steam-oxygen mixtures. An atmospheric and bubbling fluidized bed gasifier with an internal diameter of 15 cm and a total height of 3.2 m, continuously fed with 5–20 kg biomass/h, was used. Eight different catalysts from four different manufacturers were tested and the catalysts were located in a downflow fixed-bed reactor of 4 cm inner diameter placed in a slip flow after the gasifier. A guard bed with a calcined dolomite was also used before the catalytic bed to decrease the tar content in the raw gas below the limit of 2 g tar/m³, thus avoiding the catalyst deactivation by coke formation. The temperature of the catalytic bed and the gas composition in the bed were the main variables studied. The paper is mainly devoted to characterization of catalysts and to upgrading of the fuel gas. H₂ and CO contents increased by 4–14 and 1–8 vol% (dry basis), respectively. Carbon dioxide, methane and steam contents decreased by 0–14, 87–99, and 2–6 vol% (dry basis), respectively. The obtained results allow screening of the best catalysts to get an upgraded and useful gas in biomass gasification with steam-oxygen mixtures.

98/03885 A concentrated parameter model for fluid-bed flash pyrolysis of biomass

Di Blasi, C. *Biomass Gasif. Pyrolysis, [Conf.]*, 1997, 382-391. Edited by Kaltschmitt, M. and Bridgwater, A. V., CPL Press, Newbury, UK.

Based on the assumption of a well-mixed continuous reactor, a computer model of the flash pyrolysis of biomass in a fluidized-bed unit has been developed. The model describes changes in the mass concentration of biomass, char, gas and tar due to primary particle degradation, secondary extra-particle reactions, and temperature. The effects of the volumetric inert gas flow rate, the biomass mass flow rate and the furnace temperature on the product yields have been examined. Simulation results prove to reproduce the experimental observation well. Finally, a detailed transport model has been implemented to evaluate the role played by intra-particle temperature and species gradients.

98/03886 Conversion of biomass to fuel by supercritical carbon dioxide

Eisenmann, E. *Ger. Offen. DE 19,634,111 (Cl. C10G1/00)*, 26 Feb 1998, Appl. 19,634,111, 23 Aug 1996, 4 pp. (In German)

The liquefaction of biomass is performed by exposure to CO₂ at supercritical pressures and temperatures in a pressure vessel. The dissolved biomass is subsequently exposed to conventional iron, cobalt or ZnO catalysts to produce hydrocarbons, CO₂, residual gases (e.g. CO, CH₄, C₂H₆, H₂O), and solids (ashes).

98/03887 Coprecipitated Ni-Al catalyst in the pyrolysis and steam gasification of biomass

Garcia, L. *et al.* *Biomass Gasif. Pyrolysis, [Conf.]*, 1997, 249-258. Edited by Kaltschmitt, M. and Bridgwater, A. V., CPL Press, Newbury, UK.

A gas useful for electricity, synthesis gas or hydrogen production is produced by the thermal decomposition of biomass by pyrolysis and steam gasification. Low temperatures (650–700°C) cause a significant decrease in